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Balancing machines —

Part 1: Method of description and evaluation

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Foreword

This revision of this British Standard has been prepared under the direction of the Mechanical Engineering Standards Committee and is in substantial agreement with the corresponding International Standard ISO 2953 “*Balancing machines — Description and evaluation*”, prepared by ISO/TC 108 Mechanical vibration and shock and published by the International Organization for Standardization (ISO).

However, the United Kingdom has not been able to agree to the design of proving rotor for horizontal machines specified in ISO 2953; it is considered that a better assessment of the plane separation capability of a machine can be achieved, while maintaining simplicity of testing, if the tapped holes used for the test for unbalance reduction are farther from the bearings. A composite pattern of proving rotor is therefore specified, combining the pattern of tapped holes specified in ISO 2953 with that which is preferred for applications in the United Kingdom. Further comments on the differences between the two proving rotors and the method of use of the rotor specified in this British Standard are given in Appendix C.

While they are not all of the same order of importance as the change described above, certain other changes have been made to the text of ISO 2953. Among them the following should be noted.

- a) Since not all the data indicated by the skeleton headings in **3.1** (for horizontal balancing machines) or in **3.2** (for vertical machines) may be applicable in the case of any given machine, a balancing machine manufacturer is allowed a greater degree of flexibility (compared with the requirements of ISO 2953) in describing its capacity and stating its performance data. Nevertheless, it is important that, for the sake of uniformity, the layout specified by the International Standard and set out in **3.1** or **3.2** should be used as far as it is applicable to the machine in question.
- b) A greater degree of flexibility is also allowed to the manufacturer in his description of production efficiency; the nature and extent of the information to be provided should be agreed between the manufacturer and the purchaser.
- c) The relationship between the scale readings in the test for minimum achievable residual unbalance and the claimed minimum achievable unbalance has been stated more explicitly (see **9.7.6**) than in the International Standard. In this connection, the reference in Figure 5 of ISO 2953 to the arithmetic mean being “equal to five times the indicator movement” (corresponding to the claimed minimum achievable residual unbalance) is not in accordance with the usual British practice and “equal to or greater than 10 times” has been substituted.
- d) ISO 2953 is written in terms of both metric and inch-pound units; only the metric units have been retained in this British Standard.
- e) The information to be supplied to the balancing machine manufacturer by the purchaser (Annex A of ISO 2953) includes some requirements relating to administrative procedures that are not considered appropriate for inclusion in a British Standard. However, so that the whole text of ISO 2953 may be shown, they are included for this purpose only in Appendix D.
- f) The definition of minimum achievable residual unbalance in Appendix B has been amended by the addition of the words “expressed as a specific unbalance”.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 24, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

1 Scope and field of application

1.1 This British Standard sets out the procedure for describing the characteristics and evaluating the performance of machines for balancing rotating components where correction is required in one or more planes perpendicular to the shaft axis.

1.2 It is applicable to balancing machines that support and rotate rigid workpieces (i.e. workpieces that are rigid at balancing speeds) and that indicate the amounts and angular locations of unbalance corrections required.

1.3 It covers both those machines that measure out-of-balance effects on soft bearings and those that measure out-of-balance effects on hard bearings. It also relates to resonance-type machines, provided that mechanical compensators are incorporated.

1.4 Technical requirements for such balancing machines are also dealt with. Details for performance and other tests to be employed to ensure compliance with these requirements are given; however, special features such as those associated with automatic correction are not included.

1.5 Importance is attached to the form in which the balancing machine characteristics are described by the manufacturer. Adoption of the format suggested in **3.1** and **3.2** makes it easier for the user to compare one manufacturer's product with another's. Guidance on the manner in which users should state their requirements is given in Appendix A.

1.6 It should be noted that the terminology used throughout this British Standard is that contained in BS 3851 (which is identical with ISO 1925) and this terminology should be employed by manufacturers and purchasers when applying this British Standard. For the convenience of users, Appendix B gives some definitions, extracted from BS 3851, that are especially relevant to the provisions of this British Standard.

1.7 This British Standard does not specify balancing criteria; these will be found in BS 5265-1 (which is identical with ISO 1940).

2 References

The titles of the publications referred to in this standard are listed on the inside back cover.

3 Capacity and performance data

A description of the capacity and performance of a balancing machine, prepared in accordance with this Part of this British Standard, shall be suited to the design and purpose of the machine. The format shown in **3.1** shall be used to describe a horizontal balancing machine and the format shown in **3.2** to describe a vertical machine. As many of the headings shown in those subclauses shall be used as are applicable to the machine in question.

3.1 Capacity and performance data of horizontal machines

Manufacturer: Model:

3.1.1 Rotor mass and unbalance limitations

3.1.1.1	Balancing speeds or speed ranges	Min.	n_2	n_3	n_4	n_5
3.1.1.2*	Rotor mass max.: kg					
	min.: kg					
	Occasional overload force per support: N					
	Maximum negative force per support: N					
3.1.1.3†	Maximum rotor moment of inertia with respect to the shaft axis kg m ²					
	Cycle rate					
3.1.1.4‡	Maximum unbalance Measurable g mm/kg or g mm					
	Permissible					
3.1.1.5	Minimum achievable residual (specific §) unbalance (see clause 5) g mm/kg or g mm					
	Corresponding deflection of analogue amount-of-unbalance indicator: mm					

3.1.1.6 Production efficiency (see clause 6, and in particular paragraph four)

3.1.1.6.1 Time per balancing run

3.1.1.6.2 Time for mechanical adjustment

3.1.1.6.3 Time for setting indicating system

3.1.1.6.4 Time for preparation of rotor

3.1.1.6.5 Average acceleration time

3.1.1.6.6 Reading time

3.1.1.6.7 Average deceleration time

3.1.1.6.8 Other necessary time

3.1.1.7 Unbalance reduction ratio

3.1.2 Rotor dimensions

3.1.2.1 ||Rotor envelope limitations (see Figure 1)

3.1.2.2 Rotor diameter: mm
 Maximum diameter over bed: mm
 Maximum diameter over which belt can drive: mm
 Minimum diameter over which belt can drive: mm

3.1.2.3 Distance between journal centre lines:

(a) Max.: mm
 (b) Min.: mm
 (c) Maximum distance from coupling flange to centre line of farthest bearing: mm
 (d) Minimum distance from coupling flange to centre line of nearest bearing: mm

* See 3.1.5.

† See 3.1.6.

‡ See 3.1.7.

§ See 3.1.8.

|| See 3.1.9.

3.1.2.4 Journal diameter:

Max.: mm

Min.: mm

3.1.2.4.1* Maximum permissible journal peripheral speed m/s

3.1.2.5 Correction plane limitations (consistent with the statements in 4.4)

3.1.2.6 Correction plane interference ratios (consistent with the statements in 4.4 and based on the proving rotor)

3.1.3 Drive

3.1.3.1†	Balancing speed r/min	Rated torque on workpiece N m
	n_1	
	n_2	
	n_3	
	n_4	
	n_5	
	n_6	
	n_7	
	n_8	
	or	or
	steplessly variable from	steplessly variable from
		
	to	to
		

3.1.3.2‡ Zero-speed torque: % of rated torque on workpiece

Run-up torque adjustable from to % of rated torque on workpiece

Peak torque: % of rated torque on workpiece

3.1.3.3§ Type of drive to workpiece:

3.1.3.4 Prime mover (type of motor):

3.1.3.4.1 Rated power: kW

Motor speed: r/min

Power supply, voltage/frequency/phase: / /

3.1.3.5 Brake

3.1.3.5.1 Type of brake:

Braking torque adjustable from to % of rated torque

Can brake be used as a holding device? Yes/No

3.1.3.6 Motor and controls in accordance with the requirements of (indicate appropriate British Standard or other authority)

3.1.3.7 Speed regulation provided:

Accurate or constant within % of r/min, or r/min

3.1.4|| Couple unbalance interference: g mm/(g mm²)

* See 3.1.10.

† See 3.1.11.

‡ See 3.1.12.

§ See 3.1.13.

|| See 3.1.14.

3.1.5 The maximum mass of rotor that can be balanced shall be stated over the range of balancing speeds (see **3.1.1.2**). The occasional overload force need only be stated for the lowest balancing speed. It is the maximum force per support that can be accommodated by the machine without immediate damage. The negative force is the static upward force resulting from a work-piece having its centre of gravity outside the bearing supports.

3.1.6 The maximum moment of inertia [$\text{mass} \times (\text{radius of gyration})^2$] of a rotor with respect to the shaft axis that the machine can accelerate in a stated acceleration time shall be given for the range of balancing speeds ($n_1, n_2 \dots$) together with the corresponding cycle rate (see **3.1.1.3**). Cycle rate for a given balancing speed is the number of starts and stops that the machine can perform per hour without damage to the machine when balancing a rotor of the maximum moment of inertia.

3.1.7 In general, for rigid rotors with two correction planes, one-half of the stated value pertains to each plane; for disc-shaped rotors, the full stated value holds for one plane (see **3.1.1.4**).

3.1.8 For soft-bearing machines, the limits in **3.1.1.5** will generally be stated in gram millimetres per kilogram (specific unbalance) since this value represents a measure of rotor displacement and, therefore, motion of the balancing machine bearings. For hard-bearing machines, the limits will generally be stated in gram millimetres since these machines are usually factory-calibrated to indicate unbalance in such units. (See clause 5.) For two-plane machines, this is the result obtained when the minimum achievable residual unbalance is distributed between the two planes.

3.1.9 Adequate envelope drawings of the pedestals and of other obstructions such as belt drive mechanism, shroud mounting pads, thrust arms and tie bars shall be furnished to enable the user to determine the maximum rotor envelope that can be accommodated and the tooling and/or adaptors required (see **3.1.2.1**).

3.1.10 A combination of large journal diameter and high balancing speed may result in an excessive journal peripheral speed. The maximum journal peripheral speed shall be stated (see **3.1.2.4.1**).

3.1.11 When belt drive is furnished, balancing speeds shall be stated for both the maximum and minimum diameters over which the belt can drive, or other convenient diameter (see **3.1.3.1**).

3.1.12 In most cases, maximum torque is required for accelerating a workpiece (see **3.1.3.2**). However, in the case of workpieces with high windage and/or friction loss, maximum torque may be required at balancing speed. When there is axial thrust, it is necessary that provision be made to take this into account.

3.1.13 Examples of the type of drive to the workpiece are (see **3.1.3.3**):

- end drive by universal joint driver;
- end drive by band;
- belt drive;
- magnetic field;
- driven bearing rollers;
- air jet.

The manufacturer shall state if the axial position of the drive can be adjusted.

3.1.14 This value (see **3.1.4**) is applicable only to single-plane balancing machines. It describes the influence of couple unbalance in the rotor on the indication of static unbalance.

NOTE In ISO 2953 subclauses **3.1.5** to **3.1.14** are included as notes 1 to 10 to **3.1**.